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ANALYSIS OF THE 1971 SPRUCE BUDWORM PILOT TEST

NEZPERCE NATIONAL FOREST, IDAHO

October 19-20, 1971

U.S. DEPARTMENT OF AGRICULTURE - FOREST SERVICE
Division of State and Private Forestry
Missoula, Montana

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INTRODUCTION

W. J. Fillmore, Chief, Division of State and Private Forestry, Region 1, welcomed the participants. Objectives of this meeting were outlined as follows:

1. Review pilot test results.
2. Review data from related studies.
3. Develop criteria for operational use of Zectran.

The objectives of the 1971 pilot test were as follows:

1. To test the strategy of applying registered Zectran FS-15 to protect resource values on relatively small tracts until natural factors suppress surrounding budworm infestations. This will be done by remeasuring budworm population levels and defoliation within the spray blocks for at least 3 successive years.

2. To test the effectiveness of registered Zectran FS-15 in reducing budworm populations in mixed stands of true firs, Douglas-fir, spruce, and larch rather than on the pure Douglas-fir stands previously tested.

3. To evaluate the effect of registered Zectran FS-15 on budworm parasites.

Related studies included:

1. A field experiment designed to evaluate the impact of a dry liquid formulation of Zectran against the western spruce budworm. This test was a cooperative undertaking by Missoula Equipment Development Center, Pacific Southwest Experiment Station, the U.S. Army Deseret Test Center, and Region 1.

2. Use of fluorescent tracers to assess spray deposits in areas treated with Zectran. This was a cooperative study between Project 2208, Pacific Northwest Experiment Station, and Region 1.

PILOT TEST DESIGN

The experimental design for the 1971 pilot test was developed from data collected during the 1969 Zectran pilot test and discussions and consultation with two biometricians: Dr. Albert Stage, Principal Mensurationist, Intermountain Forest and Range Experiment Station, Moscow; and Dr. Donald Sisson, Biological Statistician, Utah State University, Logan, Utah. The design called for three spray blocks, 2,500 to 3,000 acres each, and three comparable check blocks. The

effect of Zectran was evaluated on two hosts--Douglas-fir and grand fir. Budworm population densities were represented in terms of numbers of live larvae per 100 buds. Data from the 1969 pilot test, where branch samples were taken at three crown levels, indicated that a mid-crown sample was sufficient for estimating budworm population densities. Sample trees were defined as full-crowned, open-grown Douglas-fir or grand fir, 40 to 50 feet total height.

The original sampling plan called for branch samples to be collected from sample trees 24 hours before spraying and a postspray sample 4 days after spraying. An additional postspray sample was taken 8 days after spraying.

One of the greatest benefits derived from the consultation with biometricians was determination of sample size. Dr. Sisson provided us with a procedure for estimating the effect of the number of trees/block and number of branches/tree on the behavior of the variance. This procedure revealed that a combination of 100 sample trees (50 Douglas-fir, 50 grand fir) per block and four 15-inch branch samples/tree was the most efficient combination of sample trees and branch samples to adequately measure western spruce budworm population densities before and after spraying.

The sampling plan was quite adequate for evaluating the pilot test results. However, it was inadequate for some of the related studies such as the spray deposit assessment test on the dry liquid experiment where individual tree or cluster sample mortality estimates were required. Increasing the number of branch samples per tree might have satisfied this requirement.

OPERATIONAL ASPECTS

I&E and publicity.--An I&E Action Plan and Situation Statement was prepared and made part of the overall project work plan. Press releases were prepared which appeared in newspapers in Spokane, Lewiston, Grangeville, and other local communities in early May. Special use permittees and adjacent private landowners were notified personally. Special letters were sent to prominent individuals in the north Idaho area, such as the Governor, local legislators, leaders of local conservation groups, and members of the Regional Forester's Inland Empire Advisory Council. Two public meetings were scheduled, one in Lewiston and one in Grangeville. Both were publicized well in advance but no interested parties appeared. The Idaho Fish and Game Department was invited to monitor the test but indicated they were satisfied that Zectran was a safe material and were convinced of its negligible environmental impact. There was no public opposition of any kind. No formal agreements were prepared. Only one of the three spray blocks (Service Flats) had adjacent private lands, and the landowners were not concerned about aerial spraying for spruce budworm.

Formulation and calibration.--Zectran FS-15 was delivered in 30-gallon drums. Deodorized kerosene was delivered by rail in a tank car. Spray was formulated in a Forest Service tank truck which provided constant agitation. Two C-47 aircraft were used to apply the spray. These aircraft were equipped with the pressurized spray system designed by Missoula Equipment Development Center. Boom pressure was 40 pounds per square inch. Spray booms on the two aircraft were equipped respectively with 103 and 104 - 8015 T Jet Spray System, Inc., spray tips.

Meteorology.--Weather monitoring for the spray project was conducted during the period June 18-24. This consisted of receiving and analyzing national weather data and collecting local meteorological data within the spray blocks. Weather during the forecast period was dominated by a persistent low aloft off the Washington coast and a ridge of high pressure over the Northern Rockies. Good weather for the 3 days of spraying can be attributed to the nearly stationary blocking high-pressure ridge to the west and the fortunate timing of brief short waves that moved through the area. The winds remained calm during the morning hours. Winds were 2 miles per hour to calm. Some gusts occurred in the early morning around 5:30 a.m.

Field collections.--Samples were taken from midcrown as consistently as possible. Fifteen 2-man crews were employed for field collections. Many of the crew members also participated in the 1969 pilot test. Permanent sample trees were not used for development sampling. Development samples were taken from neighboring trees with the same characteristics as the sample trees.

Samples were placed in plastic bags and stored under shade. The bags were stored in a refrigerated meat locker in Grangeville overnight. The reason plastic bags were favored is because the air in the plastic bag seemed to form a cushion around the samples preventing compaction and resultant injury to the larvae.

Laboratory operations.--A field laboratory was established at the offices of the Madison Lumber Company in Grangeville. This building, which has been abandoned for several years, provided excellent space for a field laboratory. A total of 38 women were employed to process development samples and prespray and postspray samples. Larval instars were classified according to charts and diagrams prepared by V. M. Carolin, Pacific Northwest Station, plus head capsule measurements. Instar determinations were made by entomologists.

Aerial spray operations.--Spray was applied on 3 consecutive days, June 22, 23, and 24. North Meadow Creek was sprayed in part on June 22. Cougar Creek and the remainder of North Meadow Creek were sprayed on June 23, and Service Flats was sprayed June 24. The aircraft were in the air shortly after 5 a.m. each morning. Spray operations were monitored by a chase plane equipped with a smoke-generating system. When the aircraft returned to the spray block with another load of spray, the starting point was marked with smoke.

Instar distribution in the spray blocks was as follows:

Location	Date of last development sample	Instar III	IV	V	VI
North Meadow Creek	06 20	3	55	40	2
Cougar Creek	06 21	6	60	33	1
Service Flats	06 22	6	54	38	1

Several problems developed during the morning of June 22. A second observer aircraft was in the area and began flying close to the spray aircraft. We had no radio communication with this aircraft and consequently were unable to get him out of the area. Shortly after, the No. 2 spray aircraft developed a leaky boom which sprayed kerosene into the exhaust system of the starboard engine. As the aircraft accelerated, the exhaust ignited the kerosene and started a momentary flash fire which burnt a hole in the fabric of the aircraft's elevator. This aircraft was grounded for the remainder of the day and the tail section was replaced later that afternoon. Ground crews neglected to activate the nitrogen cylinders which powered the spray system on the No. 1 aircraft when it came in for a second load of spray. This resulted in an inoperable boom, half of which was open and delivering spray causing an accidental spillage of Zectran from the North Meadow Creek spray block across the South Fork Clearwater River and the Camas Prairie to the Grangeville Airport. Acreages sprayed in the individual blocks were:

Location	Gallons prepared	Acres sprayed
North Meadow Creek	2,807 -150 (lost)	2,657
Cougar Creek	3,372	3,372
Service Flats	2,703	2,703

The rates of mortality in North Meadow Creek were comparable to the other two spray blocks in spite of the operational problems. We have included the information for North Meadow in our data summary.

Three physicians in Grangeville were contacted and informed of the project. We asked that they have on hand a supply of antidote in the event of accidental poisoning. The names and phone numbers of all three physicians were posted conspicuously at the airport and the field laboratory.

PILOT TEST RESULTS

Impact of Zectran on budworm.--Data summaries for the three spray blocks and three check blocks are presented in Tables 1-3. Population reduction in the treatment blocks was relatively low and quite variable. Differences between treatment and checks are statistically significant. There was no significant differences between tree species. A possible reason for the low mortality was the abundance of lush green foliage in the test area this year. This provided considerable protection for the larvae. Defoliation was negligible at the time the spray was applied. No criteria for success or failure was established. The chemical was applied and the results were evaluated.

Discussion followed about results of other tests. The Canadians experienced a lot more success. In recent tests they reported 99 percent mortality of the fifth instar. Mortality in the second instar ranged from 0 to 84 percent. One possibility for the higher mortality is that the Canadians experienced heavier defoliation, larvae were more exposed.

Impact on parasites.--Data was presented on levels of parasitism in the spray blocks and check blocks before and after spraying. All healthy larvae recovered from the prespray and postspray samples were reared in Petri dishes on an artificial diet provided by the Pacific Southwest Station. Data on parasite levels is described in the following tables:

Table 1.--Western spruce budworm population densities prespray and postspray - Nezperce National Forest, 1971.

Area	Treatment	Tree species	Number of larvae/100 buds (± 1SE.)		
			Prespray	4-day postspray	8-day postspray
North Meadow Creek	spray	GF	10.43 ± 0.85	5.52 ± 0.53	5.05 ± 0.55
		DF	13.31 ± 1.48	5.66 ± 0.89	4.45 ± 0.54
Cougar Creek	spray	GF	4.30 ± 0.41	2.13 ± 0.31	1.33 ± 0.16
		DF	3.71 ± 0.52	2.28 ± 0.31	2.06 ± 0.27
Service Flats	spray	GF	4.32 ± 0.33	2.83 ± 0.25	1.90 ± 0.26
		DF	6.21 ± 0.83	3.96 ± 0.46	2.56 ± 0.46
Tahoe Ridge	check	GF	13.35 ± 1.42	14.44 ± 1.55	13.99 ± 1.59
		DF	14.16 ± 1.71	17.31 ± 1.72	15.16 ± 1.77
Cove	check	GF	5.28 ± 0.47	5.04 ± 0.46	3.76 ± 0.34
		DF	4.04 ± 0.39	3.93 ± 0.53	3.15 ± 0.32
Free Use Road	check	GF	7.55 ± 0.79	7.46 ± 0.82	5.86 ± 0.63
		DF	9.47 ± 0.92	8.51 ± 0.72	7.48 ± 0.58

Table 2.--Four- and eight-day postspray survival ratios Zectran pilot project, Nezperce National Forest, 1971.

Area	Treatment	Tree species	Survival ratio (95% confidence limit) 4-day	8-day
North Meadow Creek	spray	GF	0.5292 ± .138	0.4846 ± .135
		DF	0.4251 ± .137	0.3346 ± .128
Cougar Creek	spray	GF	0.4947 ± .137	0.3098 ± .128
		DF	0.6154 ± .135	0.5563 ± .138
Service Flats	spray	GF	0.6563 ± .132	0.4394 ± .137
		DF	0.6383 ± .133	0.4124 ± .136
Tahoe Ridge	check	GF	1.0819	1.0482
		DF	1.2224	1.07
Cove	check	GF	0.9505 ± .050	0.7097 ± .126
		DF	0.9750 ± .043	0.7813 ± .114
Free Use Road	check	GF	0.9881 ± .030	0.7771 ± .115
		DF	0.8985 ± .083	0.7897 ± .114

Table 3.--Corrected percent mortality western spruce budworm pilot test - Nezperce National Forest.

Area	Tree species	Corrected % mortality due to Zectran[1/]	
		4-day	8-day
North Meadow Creek	GF	51.09	53.77
	DF	65.22	68.08
Cougar Creek	GF	47.96	43.41
	DF	36.89	28.42
Service Flats	GF	33.58	43.46
	DF	28.96	47.78

1/ Corrected % mortality derived as follows:

$$100\ (1.0 - \frac{\text{survival treated}}{\text{survival control}})$$

Table 4.--Percent parasitism by species - spray blocks.

Parasite	Collection period		
	Prespray	4-day postspray	8-day postspray
Apanteles	3.633	3.700	6.650
Glypta	2.550	2.816	2.966
Tachinids	1.566	2.466	2.766
Other parasites	.166	.483	.150
Total	7.916	9.466	12.522

Table 5.--Percent parasitism by species - check blocks.

Parasite	Collection period	
	Prespray	4-day postspray
Apanteles	1.920	1.730
Glypta	1.910	1.380
Tachinids	4.860	4.650
Other parasites	.161	.231
Total	8.851	7.991

Parasitism increased slightly in the spray blocks after spray was applied but did not increase in the check blocks. Levels of parasitism were relatively low in the 1971 pilot test sites. Parasite data for previous pilot tests were presented for comparison (Table 6).

Table 6.--Level of parasitism of western spruce budworm in 1968 - Zectran pilot test.

Test	Spray block	Percent parasitism	
		Prespray	Postspray
1968 Belmont and Chamberlain Creeks	Belmont	19.0	25.2
	Chamberlain	11.0	22.7
1969 Belmont and Chamberlain Creeks 1 year after spraying	Belmont	20.4	14.8
	Chamberlain	18.8	14.3
1969 Nezperce test	Fish Creek	7.4	18.2
	Skookumchuck	10.6	14.1

SPRAY DEPOSIT ASSESSMENT

Data in the use of Rhodamine-B extra base fluorescent tracer as a spray deposit assessment method in the Service Flats spray block was presented by personnel of the Pacific Northwest Station. These data have been summarized in a progress report issued by the Pacific Northwest Station (Maksymiuk et al. 1971).1/

DRY LIQUID FIELD EXPERIMENT

In June 1971, a field experiment using new concepts of insecticide application was carried out. This field experiment investigated the use of preformed discrete particle sizes to carry an insecticide. By using a liquid-solid blender, we produced a solid consisting of 60 percent to 40 percent liquid (TPM) - solid (Microcel E) weight - weight. This dry liquid preparation contained 0.15 pound Zectran per 1.39 pounds dry liquid. The particle size was initially analyzed and was believed to consist of particles ranging in size from 5 to 50 microns diameter with an m.m.d. of about 30 microns.

The field test was carried out near White Bird, Idaho, in cooperation with personnel from Missoula Equipment Development Center, Region 1; the Deseret Test Center; and Pacific Southwest Experiment Station 2203. Pacific Southwest 2203 determined the biological activity of the dry liquids, recommended Microcel E, and suggested the use of Tinopal SFG

1/ Maksymiuk et al. 1971. A field experiment in determining the effectiveness of Fluorescent Tracer Rhodamine for assessing spray deposits of registered Zectran formulation (Nezperce National Forest Idaho, 1971). U.S. Dept. of Agriculture, U.S. Forest Service, Pacific Northwest Forest and Range Experiment Station, Forestry Sciences Laboratory, Corvallis, Oregon.

as a fluorescent marker. Missoula Equipment Development Center did all of the development on the application system and organized and directed most of the application. Region 1 provided the budworm survey, the budworm sites, and all of the sampling, both prespray and postspray. The Deseret Test Center provided men and materials to carry out an extensive meteorological evaluation and particle sampling system. Deseret provided the information that application to a ridgetop at sunrise would move the formulation down into the canopy with a single pass using a dust-dispensing fixed-wing aircraft previously calibrated by Missoula Equipment Development Center.

After a few delays due to inclement weather, mainly rain, the test went off as scheduled. Approximately 400 pounds of dry liquid containing 0.15 pound Zectran per 1.39 pounds were released at daybreak over the plot ridge in 1.37 minutes at 120 miles per hour ground speed.

The air speed at the ridgetop was 5 miles per hour and it carried the cloud into the canopy with great precision. Rotorod samplers and Gelman air samplers indicated good distribution throughout the plot. Mortality measurements after application indicated essentially no reduction in the budworm population.

DISCUSSION

Discussion began on development of criteria for spraying spruce budworm infestations. Basic questions such as: "Is the spruce budworm a problem?" and "When is it economically feasible to control budworm?" were discussed.

Personnel of the Flathead Indian Agency, Bureau of Indian Affairs, Ronan, Montana, discussed their current spruce budworm problems. There are one-half million acres of commercial forest land on the Flathead Indian Reservation. The spruce budworm has reached epidemic levels in the southeastern portion of the reservation near Arlee. Some mortality of host trees has occurred due to repeated defoliation. The spruce budworm is rendering trees unfit for harvest as Christmas trees. This may be a loss of $50,000 of income to the tribal members.

The Bureau of Indian Affairs feels that some positive action must be taken even though the total loss cannot be measured. A project proposal is to be submitted for aerial spraying of spruce budworm infestation on 50,000 acres of tribal land. Tentative plans are being made for helicopter application.

Discussion then turned to the current status of Zectran as an operational control method for the western spruce budworm. It was pointed out that the 1971 pilot test was well designed and conducted. There was virtually no deviation from the study plan. Yet, mortality was still low. The chemical appears to be very effective in the laboratory but at the present time the odds of having a successful operational project are low.

Various areas where improvements could be made in applying Zectran were mentioned. These included large spray block versus small spray block strategies, improving aerial application techniques, helicopter versus fixed-wing aircraft, morning versus evening spraying, and spray droplet spectrum. Timing of spray to coincide with maximum susceptibility of the target insect was discussed. A comparison of the Idaho and Maine Zectran pilot test was made. The Maine test was highly successful (95+ percent control). The following is a summary of the two tests.

	Maine	Idaho
Air speed of spray aircraft	170 m.p.h.	150 m.p.h.
Droplet size (m.m.d.)	150-160	113.7
Aircraft	TBM	C-47
Terrain	Level	Mountainous
Nozzel size	8015	8015
Altitude above trees	100 ft.	300-500 ft.
Percent in fifth instar	75	33-35
Hosts	Balsam fir-red spruce	Douglas-fir - grand fir

The situation was summarized by citing a similar example. Dow Chemical Company had developed a chemical which underwent 35 independent experiments, all highly successful. The 36th test was a complete failure. After thorough checking no one could determine the cause of the failure so they attempted to repeat the failure which they were unable to do. As long as a product does work well under certain conditions, don't set it aside but continue working with it.

Discussion continued on criteria for suppression projects. It was generally agreed that the resource manager must have clearcut management objectives in mind for his lands if he is to have a sound basis for deciding for or against control.

PARTICIPANTS

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